BOTANICAL GAZETTE

FEBRUARY, 1894.

Contributions from the Cryptogamic Laboratory of Harvard University. XXII.

Observations on the genus Naegelia of Reinsch.

ROLAND THAXTER.

WITH PLATE V.

In his paper entitled "Beobachtungen über einige neue Saprolegnieæ, etc.," published in Pringsheim's Jahrbücher about fifteen years since,[1] Reinsch has described and figured a peculiar fungus to which he gave the name *Naegelia* including under it two supposed species which he referred to in the text as "species I" and "species II" respectively, without further specific designation. The genus, which like Leptomitus and its allies is characterized by the division of its hyphæ into segments through the presence of successive constrictions, was based on its peculiar habit, any given hyphal segment producing distally whorls of sporangia and branching in a characteristic fashion. Although this habit is clearly indicated by the original figures and description, Cornu[2], in the year following Reinsch's publication, referred the genus unreservedly to his own *Rhipidium interruptum*, a form characterized by an extreme differentiation between a monstrously developed basal cell and the numerous branches arising from it, the habit of which, if published data may be relied upon, is quite different from that of the form under consideration. Nevertheless according to Cornu, single detached branches of *R. interruptum* are alone responsible for the creation of "Naegelia," a name, as he points out, inadmissable from its previous use in at least two instances. With this exception

[1] 11: 298. 1878.
[2] Bull. Bot. Soc. de France 1879. 226.

few references to Reinsch's genus are discoverable. Fischer in his recent work[3] retains the name *Naegelia* Reinsch, without further designation of the species, placing it under the insufficiently know genera included by him in the sub-family "APODYEÆ," with the remark that it cannot be considered identical with Rhipidium. Still more recently Schröter[4], without reference to the opinions of Cornu, assumes its distinctness and places it among the "LEPTOMITACEÆ," proposing as a substitute for the preoccupied Naegelia the modification *Naegeliella*, with one species, *N. Reinschii* n. g. et n. s., equivalent to the "species I" of Reinsch. Lastly Fritsch[5] calls attention to the preoccupation of Naegeliella for a genus of fresh water algæ and proposes a third name *Sapromyces* nov. gen. distinguishing two species, *S. Reinschii* (Schröter) Fritsch and *S. dubius* nov. sp., the last an equivalent for "Naegelia species II."

The last three references, for the most recent of which the writer is indebted to the kindness of Prof. Farlow, appear to be based wholly on the original account of Reinsch, the genus not having been observed since its first discovery. In view of the fact that this account has been discredited by the criticisms referred to, and is moreover defective in important points, the following observations may be of interest, based as they are on the examination of fresh material obtained during the past season.

The plant in question was first met with by the writer in the vicinity of York, Me., where it was found growing on a pine cone that had fallen into a wood pool of clear cold water. On this substratum the sporangiferous hyphæ were luxuriantly developed, forming a layer around it nearly a centimeter thick, but not very conspicuous from its transparency. The discharge of zoospores was repeatedly observed in this material; but no indication was seen of the presence of any form of sexual reproduction. Later in the season (September) the pool was again visited and additional specimens secured growing upon submerged fragments of branches, one of which furnished fine examples of the curious oogonia and antheridia. An examination of this material has afforded the data for the following account, but unfortunately no observations could be made

[3] Phycomycetes in Rabenh Kryptogamenfl. (Pilze) **1**: pt. 4. 377. 1892.
[4] Engler and Prantl. Naturl, Pflanzenf. **1**: 103.
[5] Œsterr. bot. Zeitschr. **43**: 420. 1893.

at the time either on the germination of the oospores or the details connected with the process of fertilization.

Hyphæ.—The hyphæ, as has been already stated, consist of successive segments connected by constricted portions, which may be plugged by a deposit of cellulin, or, more commonly, are without any such pseudo-septum, the contents of successive segments being, as a rule, in direct communication with one another. The primary axis originates as a single basal cell or segment which is attached by its roughened surface directly to the substratum, without rhizoidal outgrowths. It is often more or less bent and distorted but otherwise undifferentiated, except that its protoplasmic contents may be separated into isolated masses (fig. 9), through the partial obliteration of its cavity by deposits of cellulin. Above this basal segment the habit of growth characteristic of the plant begins directly. The primary axis may be continued by several successive segments, but more frequently it divides almost immediately into two or more secondary axes. This successive and more or less irregular multiplication of axes is continued from the base to the summit of the plant, any given segment producing distally one to several similar segments, the whole resulting in a copiously branched and spreading structure. In addition to the new segment or segments which may arise from the distal end of any given segment, reproductive organs, whether zoosporangia, oogonia or antheridia, are usually produced either singly or more commonly in whorls of from two to (rarely) six, zoosporangia being often associated in the same whorl with oogonia or with antheridia. Each of the organs just mentioned is separated from its parent segment by the characteristic constriction which in the case of the zoosporangia and oogonia is furnished with a cellulin plug.

Zoosporangia.—The zoosporangia, which may be terminal as well as lateral, are very variable in size and shape, usually sub-cylindrical, often elongate but sometimes oval or elliptical. The more stunted forms with short and stout sporangia (fig. 3), corresponding to Reinsch's "species II" are, as has been suggested by Fischer, merely conditions of the more typical form, resulting apparently from the lack of nutrient material in the dead twigs on which this type occurred. The sporangia are very frequently attacked by chytridiaceous parasites, and in such cases often become considerably distorted

or otherwise modified, and although no resting spores were observed in any of the sporangia thus attacked, the thick walled spherical "oospores" described by Reinsch[6] as occurring, several in an "oogonium," are undoubtedly of this nature. At maturity the dense granular protoplasm within the sporangium divides into a large number of zoospores.

Zoospores. — The zoospores make their escape directly through a terminal pore without any interval of rest, swarming immediately after emergence and even while still within the partly emptied sporangium (fig. 2). They are sub-reniform in shape, biciliate and apparently monoplanetic, although this character was not definitely determined. In several instances when the discharge was observed directly, there was no indication of any process similar to that described by Cornu in Rhipidium, where the contents of the sporangium is said to be discharged simultaneously as a mass of zoospores which are then set free by the rupture of a thin surrounding membrane.

Antheridia.—The branches which terminate in antheridia arise like the zoosporangia terminally or more often laterally in whorls of several members and although often associated with zoosporangia do not occur in any of the specimens examined, on plants which produce oogonia. They are much more slender than the ordinary hyphæ, with few constrictions, often very elongate, flexuous, or often more or less irregularly spirally twisted especially just below the terminal antheridium. They may be several times branched, and are slightly constricted at such points, while the free tips, finding their way to the oogonia, become rather abruptly swollen into the antheridium proper. The antheridia are irregularly cylindrical, sometimes divided by a septum (fig. 5), and adhere closely to the oogonium, often winding partly round it, before reaching its receptive apex through which an entrance is effected by means of a beak-like process, which, pressing the wall of the oogonium inwards, perforates it at the bottom of the depression thus formed. Two antheridia (fig. 8), or even three, may be applied to a single oogonium invariably at its apex, their pollinodia penetrating side by side to the oosphere. After penetration there seems to be open communication between the oosphere and antheridium (fig. 5), but whether any interchange of contents takes place between them could not be determined from the material examined. As the oospore

[6] l. c. 11: *pl. 15. f. 4-5.* 1878.

matures the beak-like pollinodium becomes closed, its walls are greatly thickened, and its cavity sometimes wholly obliterated, so that even in old oogonia it is very sharply defined, the old antheridium also persisting and becoming somewhat thicker walled.

Oogonia.—The oogonia are either terminal or more frequently, like the sporangia with which they are often associated (fig. 4, *x*), borne laterally either singly or in whorls from the distal ends of the hyphal segments. They are nearly spherical or in the majority of cases piriform in shape, becoming covered with a brown flaky incrustation disposed transversely, and are separated from the segment which bears them by the usual constriction, which is always plugged (fig. 6) by a deposit of cellulin. Antheridia and pollinodia were present on every oogonium in the material obtained, even in the youngest specimens. In the latter the contents entirely fills the oogonium and consists of numerous large masses of refractive fatty protoplasm embedded in a more finely granular matrix. As this mass contracts to form the oospore a small amount of residual protoplasm remains unused outside it (fig. 5).

Oospores.—The oospores are always solitary in the oogonia, spherical, with very thick translucent walls which are slightly yellowish. The exospore, though slightly irregular in outline, shows no signs of any characteristic modification. Their germination was not observed.

From the above account it is manifest that the genus Sapromyces is very closely related to Rhipidium as far as can be determined from the fragmentary descriptions of this genus which are available. It is left quite uncertain by Cornu's account how much importance should be attached to the differentiation between the basal cell of Rhipidium and its branches, but if this character is as strikingly pronounced in the three remaining species as it is in *R. interruptum*, it would seem to constitute alone a sufficient basis for generic separation. Whether the differences existing in the method by which the zoospores are discharged in either case should also be considered of generic value can hardly be determined without further comparative observations. The characteristic branching and the verticillate arrangement of sporangia, relied upon by Reinsch as a basis for his genus, would seem, however, to be of comparatively slight importance.

In connection with the general habit of Sapromyces it may be noted that Reinsch in his first description,[7] where his subsequent "Naegelia species II" is described and figured as "Hyphomycetarum nov. gen." represents the sporangiferous hyphæ as arising at intervals from a "stroma ex filis tenuioribus elongatis subramosis inter muscos aquaticos intricatis formatum," but no reference to this mode of growth is made in his second paper; and since no such habit was observed by the writer, the account just quoted is presumably of doubtful accuracy.

That the species under consideration is not identical with *R. interruptum*, as asserted by Cornu, seems sufficiently manifest, since it lacks the highly differentiated basal cell, its sporangia are verticillate and its oospores are nearly smooth; while the receptive portion of the oogonium is always terminal, not "vers la base."[8] The close resemblances between the sexual organs and their action in the two genera is certainly striking: yet until further data are obtained concerning these phenomena in other genera of the sub-family, it seems not unreasonable to assume that they may have a more than generic significance.[9]

The form may be briefly characterized as follows:

SAPROMYCES REINSCHII (Schröt.) Fritsch.

Fritsch, Œsterr. bot. Zeitschr. **43:** 420. Dec. 1893.

Hyphomycetarum nov. gen. Reinsch, Contrib. ad Algol. et Fungol. 99 (Chloroph.) *pl. 14 f. 1. a–d.* 1875.

Naegelia species I et *species* II, Reinsch, Pringsheim's Jahrbücher, **11:** 298. *pl. 15. f. 1–11.* 1878. Fischer, Phycomycetes in Rabh. Kryptogamenfl. Pilze **1:** pt. 4. 377. 1892.

Naegeliella Reinschii Schröter, Engler and Prantl, Die Natürl. Pflanzenf. **1:** 103.

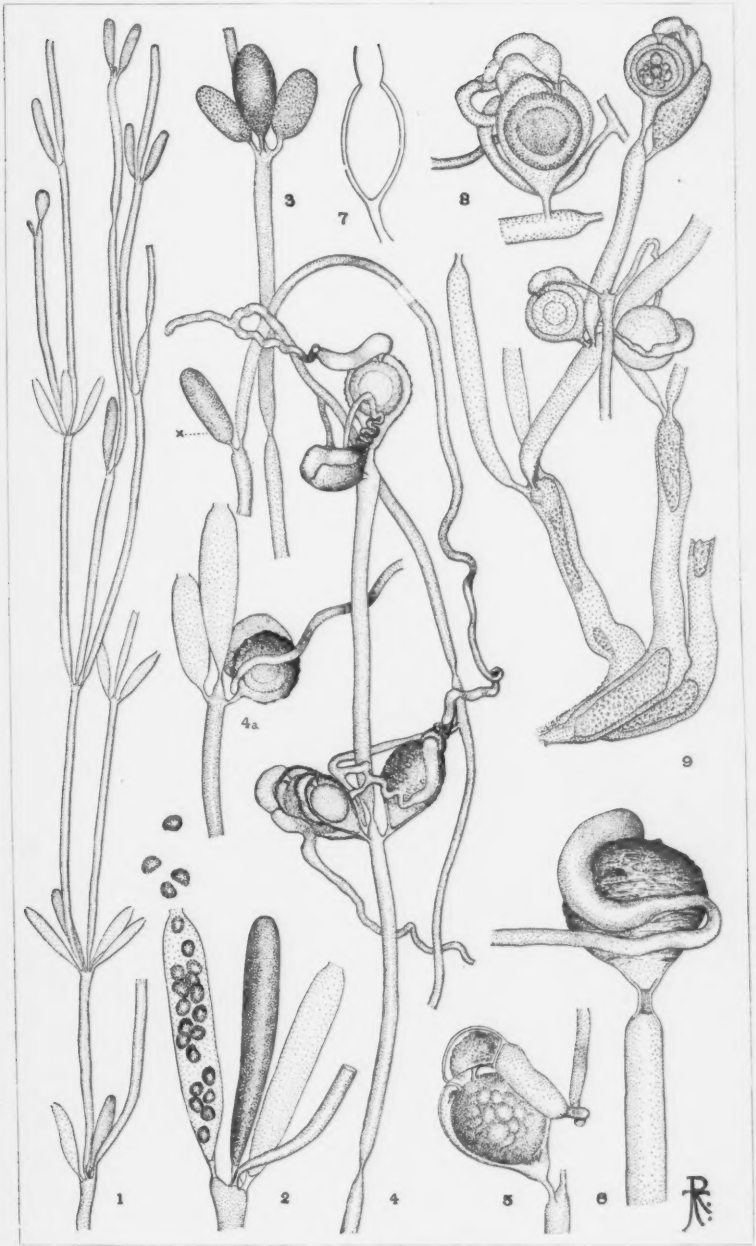
Sapromyces dubius Fritsch, l. c.

---

[7] Contrib. ad Algol. et Fungol. 99 (Chlorph.) *pl. 14. f. 1. a–d.* 1875.

[8] Cornu, Ann des Sci. Nat. V. **15:** 30. 1872.

[9] The phenomena described by Prof. Humphrey (Saprolegniaceæ of the U. S., etc.,) in connection with the singular form described by him as *Apodachlya? completa*, do not, in the writer's opinion, afford sufficiently definite information on this point, in view of the uncertainty which exists as to their true significance. Both Rhipidium and "Naegelia Reinsch" appear to be excluded from the Leptomiteæ of Humphrey, yet it seems best on the whole, in the absence of further information, to assume the near relationship of those two genera with Leptomitus and Apodachlya, in conformity with the views of Fischer and Schroeter in the papers already cited. In this connection the close resemblance may be noted between the so-called chlamydospores of Apodachlya and the oospores of Sapromytces.



THAXTER on NAEGELIA, Reinsch.

THE
JOHN CRERAR
LIBRARY

Hyphæ composed of numerous successive nearly cylindrical segments, arising one to several from undifferentiated basal segments attached to the substratum, each segment producing distally one to several similar segments, as a rule, bearing distally whorls of zoosporangia, oogonia and antheridial branches, the sexual organs on separate plants, but often associated with zoosporangia in the same whorl. Sporangia one to six in a whorl, slender sub-cylindrical to sub-clavate or stout and oval to elliptical or oblong. Oogonia sub-spherical to piriform becoming covered at maturity by a brown flaky incrustation disposed transversely, and containing a single spherical nearly smooth thick-walled oospore. Antheridia irregularly cylindrical, abruptly distinguished from the antheridial branch, sometimes divided by a septum, penetrating the oogonium always at its apex by a beak-like pollinodium. Hyphæ 7–30μ in diameter, the segments (larger) 450 × 10–15μ. Zoosporangia 22–25 × 35–200μ. Oogonia 26–40 × 32–55μ. Oospores 20–30μ.

On Viscum stems and algæ, Germany (Reinsch). On cones and twigs of Pinus in a spring, York, Maine.

Cambridge, Mass.

EXPLANATION OF PLATE V.

Sapromyces Reinschii (Schröt.) Fritsch.

Fig. 1. General habit of sporangiferous hyphæ.—Fig. 2. Whorl of three sporangia, one empty, the next before and the third during the discharge of zoospores, the axis segment turned to the right.—Fig. 3. Portion of hypha bearing stouter sporangia (Naegelia species II) before the discharge of zoospores.—Fig. 4. Hypha bearing oogonia, one of which is terminal. Also portions of two hyphæ producing antheridial branches, one of them also a zoosporangium, x.—Fig. 5. Oogonia and septate antheridium, a small collection of periplasm near the base and apex of the oosphere.—Fig. 6. Terminal oogonium with non-septate antheridium showing flaky incrustation of oogonium wall, a cellulin plug filling its constricted base.—Fig. 7. Empty thick walled sporangium.—Fig. 8. Oogonium showing oosphere with two antheridia attached.—Fig. 9. Three basal cells scraped from substratum, their cavities partly obliterated, that on the left giving rise to a sporangium and segments bearing oogonia and sporangia.

Fig. 1. Zeiss A, oc. 2. Figs. 2–4, 9. D, oc. 2. Figs. 5–8. D, oc. 4. Photo-reduced from ink drawings.

On some species of Micrasterias.

L. N. JOHNSON.

WITH PLATE VI.

The genus which forms the subject of these notes includes some of the largest and most beautiful of the Desmidieæ. During the past summer the writer has had an opportunity of studying an abundance of material of a number of species, including one or two rare forms. Some of the facts noted do not appear to have been previously recorded, though apparently of considerable importance. Most of the material was collected on Long Island, in several large ponds, at Cold Spring Harbor.

Probably the most interesting find was *Micrasterias foliacea* Bailey. This was very abundant in one gathering made by rinsing waterweeds. The species was first described by Prof. Bailey, in 1847, in a letter to Ralfs, and was published and figured by the latter in his British Desmidieæ.[1] It is apparently not a common species, though widely distributed. It has been reported from Burmah by Joshua,[2] from Bengal by Wallich,[3] from Java by Nordstedt. In this country Wolle found it once or twice,[4] but no one else appears to have reported it since Bailey's original discovery. Prof. Nordstedt has described[5] a variety *ornata*, from Brazil, differing from the type only in having, on the superior margin of the intermediate lobe and the inferior of the basal lobe, two small aculei.

In the material studied the cells are usually found joined end to end in long ribbon-like chains (fig. 1), though single cells are not uncommon. In some cases over a hundred cells were counted in a single filament, and the number appears to be limited only by the strength of the connection of the cells and the strain put upon it. Wallich appears to have been the

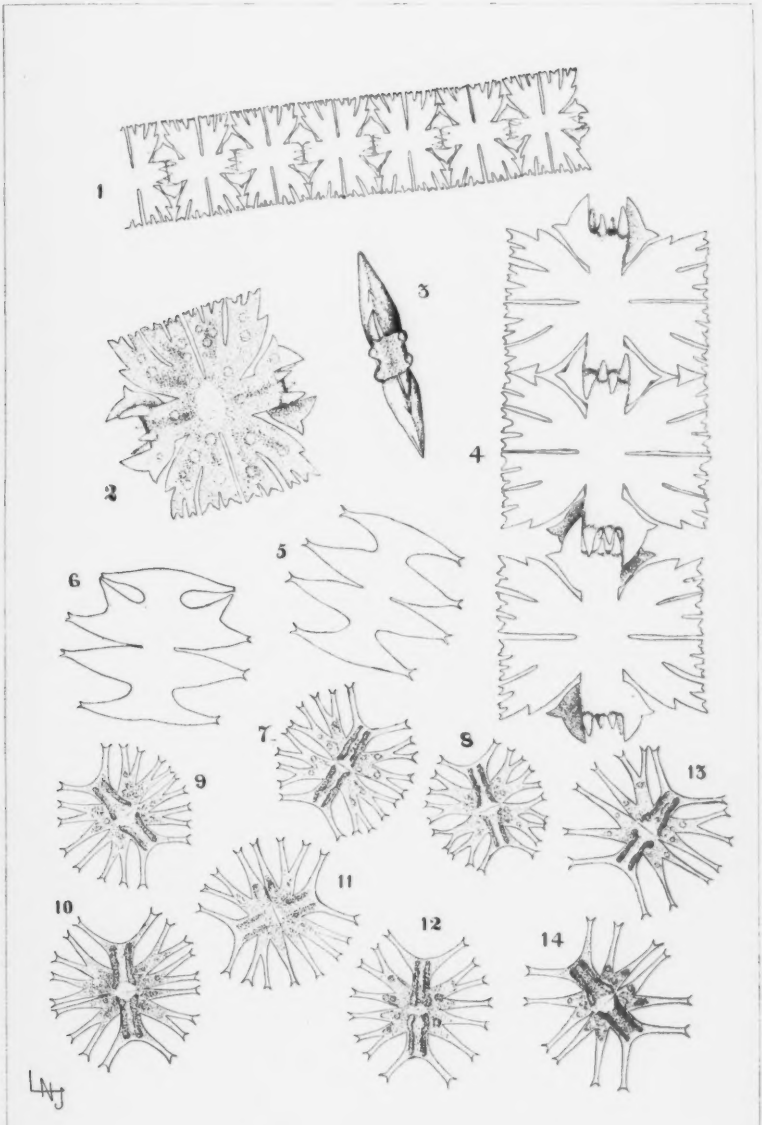
[1] The British Desmidieæ. 210. *pl. 35. f. 3.* 1848.

[2] Burmese Desmidieæ, Journal of the Linnean Soc. **21:** 636. 1886.

[3] Description of Desmidieæ from lower Bengal. Ann. and Mag. of Nat. Hist. III. **5:** 280. *pl. 14. f. 1–3.*

[4] Bulletin of Torrey Botanical Club **9:** 27. 1882. Desmids of the United States, 118. *pl. 38. f. 10, 11.* 1884.

[5] Symbolæ ad floram Braziliæ centralis cognoscendam. Particula quinta. Desmidiaceæ. Vidensk. Medd. fra den naturh. Forening i Kjöbenhaven 221. *pl. 2. f. 16.* 1869.



JOHNSON on MICRASTERIAS.

THE
JOHN CRERAR
LIBRARY

first to notice the union into filaments.[6] Wolle found the filaments, and states[7] that the cells are held together by the overlapping of the end lobes.

It is in connection with the form of this end lobe, and the means by which the cells are joined that the descriptions by various authors are most indefinite or confused. The figure in Ralfs' British Desmidieæ is very defective, and justifies Wallich's remark that neither Bailey nor Ralfs seems to have noticed the minute details of structure. Wallich describes the form which he found as *var.* β, but it seems scarcely distinct from the type. He describes it as emarginate, with one spine on each surface, the two being diagonally opposite. He figures a chain of three cells, but they could not possibly be joined in the manner represented by him.

Rabenhorst[8] mentions the species as one not yet found in Europe, and states that the emarginate polar lobe is bidentate on each surface. Later writers seem to have followed him, and the statement is true, as far as it goes. The best figures of the terminal lobe are given by Nordstedt,[9] but there are some points not made clear by his plate and description.

The form of a single cell is shown by the accompanying drawing (figs. 2 and 3). The lateral margins of the frond are nearly straight and parallel, and the end lobe projects but slightly beyond them. This lobe is deeply emarginate, with an almost rectangular sinus. The portion on each side of the sinus is depressed on one surface, in such a way that the two depressions lie diagonally opposite each other. This is very difficult to describe, but may be easily understood by reference to the drawings. At the base of the sinus on either surface of the frond are two tooth-like projections. These have been often noticed before, but one peculiarity seems to have been overlooked. The tooth on the side adjoining the depression is nearly twice as large as the other. An examination of hundreds of specimens shows this to be constant.

The manner in which the cells are joined in the filament may be seen from fig. 4. The lower cell is slightly separated from the next, showing the manner in which the lateral portions of the end lobes of the two fronds are dovetailed to-

[6] Loc. cit.
[7] Desmids of the United States, 118.
[8] Flora Europaea Algarum aquæ dulcis et submarinæ. **3**: 195. 1868.
[9] Loc. cit.

gether. When the cells fit closely together the projecting teeth interlock. It would be difficult to imagine a more rigid connection than this. The firmness of the union and the shape of the cells give the filaments little flexibility, and they are usually nearly straight.

Unfortunately it was impossible to work out the development of the terminal lobe, as no specimens were found undergoing division.

Micrasterias pinnatifida (Kütz.) Ralfs was another species studied. This is closely related to *M. oscitans* Ralfs, if indeed it is not merely a variety of that species. It was first described by Kützing[10] as *Euastrum pinnatifidum.* The ordinary form of cell is that shown in fig. 5, but occasionally a specimen was found with one semicell curiously distorted (fig. 6). Several cells were seen which showed this inflation of the basal lobes in one semicell, but none were found with both halves abnormal. This appears to be the same as the var. *inflata* of *M. oscitans* Ralfs described by Wolle.[11] If so his form can hardly be called a distinct variety, since we should then have specimens, one half of which was typical, while the other belonged to the variety. The most we can say is that the frond sometimes varies, with the lateral lobes inflated and produced slightly at the angles.

A species which proved in some respects the most interesting of all those studied was *M. furcata* Ag. This is one of the best known species in the genus, having been described by Agardh[12] in 1827. It is a form which is widely distributed, and has been many times described, yet some interesting peculiarities seem to have been unnoticed. The typical form of the species is shown in figs. 7 and 8. The former is from a Long Island specimen, while the other was collected on the other side of the Sound in Connecticut, but not fifty miles distant. One peculiarity of Connecticut specimens was their small size. The average diameter of thirty specimens measured was 120μ, the extreme measurements being 108μ and 132μ. De Toni[13] gives 113–205μ as the range of variation of the species. The Long Island specimens were larger, the typical ones averaging 133μ, with extremes of 120 and

[10] Phycologia Germanica 134. 1845.
[11] Bulletin of Torrey Botanical Club. **6:** 122.—**8:** *pl. 6. f. 5.* 1881.
[12] Flora **10:** 643. 1827.
[13] Sylloge Algarum omnium hucusque cognitarum. **1:** 1114. 1889.

156μ. In another respect the latter are remarkable. The typical form, as is well known, has each of the four lateral lobes deeply bifid, but such specimens are not numerous in this material. The cell shows a decided tendency toward a form with simple lobes (fig. 14). Scores of specimens were examined of which no record was made, but of thirty taken at random which were measured, eleven were typical, two had one simple lobe, five had two, two had three and the same number four, three had but two typical lobes each, three had but one, while two were of the form shown in fig. 14, with all the lobes simple. Some of these varieties are shown in figs. 9–13. Sometimes all the abnormal lobes are in one semicell, while the other is normal, but quite as often some lobes of each are simple, and these may be on the same or opposite sides of the frond. A curious and rather puzzling fact is that the lobes nearest the base of the semicell show the greatest tendency to this variation. If there are not more than four simple lobes these are almost invariably the basal ones. Only one exception to this was found among all the specimens examined.

Another noteworthy fact is that the abnormal forms are almost invariably larger than the typical. Of the thirty specimens measured the eleven typical ones averaged 133μ, while the others averaged 163, and the average of those having over four simple lobes was 182, with extremes of 165 and 200μ. Only two abnormal specimens measured less than 140μ. Often the difference could be seen in a single cell, the varying half being decidedly larger than the other.

In the material collected in Connecticut, only a week or two after the former collection, these variations were very infrequent, but they were found occasionally. Of thirty specimens all but three were of the typical form. Of the three, one showed one semicell of the typical form, while the other was of the extreme form, with all the lobes simple.

Turner has described and figured a variety *decurta*[14] of *M. furcata* Ralfs which seems to be this simple form. He says of it that it is "a strange and apparently abnormal form. Only two semicells seen, of which one possessed a curious double lobelet." His material was from Watertown, N. Y.

It is hardly necessary to call attention to the close re-

[14] On some new and rare desmids. Jour. Royal Micr. Soc. **5**; 936. *pl. 16. f. 10.* 1885.

semblance between the simplest form here described and Mr. Wolle's description and figure[15] of *M. pseudofurcata*. The chief distinction given by him for this species is that it has "only half as many lateral arms" as *M. furcata*. The original figure of *M. pseudofurcata* Wolle, in the Bulletin of the Torrey Botanical Club is almost exactly like fig. 14, and probably represents the same form.

In this connection it is of interest to note Wolle's description of *M. furcata* var. *simplex*.[16] From this it will be seen that he collected and examined in Florida a series of forms showing all possible gradations from a form with two simple lateral arms on each side to one with but one simple lobe on each side of the semicell. He himself calls attention to the resemblance of the former to *M. pseudofurcata* Wolle, and says that it needs further examination.

Combining these facts it seems to the writer that we are justified in no longer recognizing *M. pseudofurcata* Wolle as a distinct species, since a whole series of forms has been found connecting it with *M. furcata* Ag. while the Florida forms described by Wolle connect it with the simple three lobed form. The varieties, *decurta* Turner, and *simplex* Wolle, simply represent forms in this series of variations, and not true varieties. We must then regard *M. furcata* Ag., as an extremely variable species, and our description must be modified to include forms with the lateral lobes two or four, simple or bifid.

No cause could be discovered for the greater variability of the Long Island specimens unless it may be the lower temperature of the water, the Connecticut specimens being from a shallow pool, where the water was quite warm. The larger size of the Long Island forms would perhaps indicate better conditions for vigorous growth.

Botanical Laboratory, Univ. of Michigan, Ann Arbor.

EXPLANATION OF PLATE VI.

(All figures reduced one-sixth in engraving.)

Fig. 1. Portion of a filament of *Micrasterias foliacea* Bailey. × 200.—Fig. 2. Single cell of same. × 400.—Fig. 3. Vertical view of frond, showing form of terminal lobe. × 400.—Fig. 4. Series of three cells, showing manner of joining. × 400.—Fig. 5. *Micrasterias pinnatifida* (Kütz.) Ralfs. × 400.—Fig. 6. Same, showing abnormal semicell. × 400.—Fig. 7. *Micrasterias furcata* Ag., typical form: Long Island. × 160.—Fig. 8. Same, Connecticut. × 160.—Fig. 9–13. *M. furcata* Ag. showing variations. × 160.—Fig. 14. Same; form with lateral lobes all simple. × 160.

[15] Bulletin of Torrey Botanical Club. **12**: *pl. 51. f. 6, 7.* 1885.

[16] Freshwater algæ of the United States 40. *pl. 59. f, 6, 7.* 1887.

On the development of the bulb of the adder's-tongue.

FREDERICK H. BLODGETT.

WITH PLATES VII AND VIII.

Hundreds of small plants of the adder's-tongue, or spring lily *(Erythronium Americanum* Ker.) are found in the spring with the bulbs less than five inches below the surface of the soil, each bearing a single leaf and no flowers, while comparatively few plants bearing two leaves and a flower each are found, and bulbs of these are at depths varying from five to nine inches.

The question has been raised as to the method by which the mature bulbs reach their great depth.

Early in March, 1893, I helped to fill a window box with surface mold taken from the woods, containing small bulbs of the *Erythronium*, apparently seedlings. These bulbs, which were found less than three inches from the surface of the ground, developed each its single leaf (fig. 1), which died down in a month or so. When the earth was removed from the box to make room for other plants, the bulbs were found to have developed runners with bulb-like thickenings at the ends (fig. 7). Having thus gained a clue as to the way in which the bulb of a flower-producing plant is formed at the depth at which it is found, many other plants were examined in various stages of development. The bulbs of the plants which produced flowers this year are called flowering bulbs in these notes, in distinction from those of the younger plants which are termed seedlings or secondary bulbs according to size and age.

The runners start from the bottom of the bulb, but vary both in length and direction of growth, being from two to nine inches long, and ranging from perpendicular to nearly or quite horizontal (figs. 2–5). As the supply of nourishment in the parent bulb is exhausted, the tip of the runner thickens into a secondary bulb, which sends out rootlets from the upper part (fig. 11), and then the runner is absorbed, leaving, in the cases examined, nothing but a dry and empty husk of the parent bulb and runner. These secondary bulbs later in the season lose their fleshy rootlets from the upper part of the bulb and send out the fibrous roots from the base.

The number of runners varies from one to three in the plants examined, and they grow in different directions. These runners are from two to nine inches long, so that if they grew vertically the bulb might be formed at the depth of the flowering bulbs, but they run obliquely more frequently than vertically thus leaving the secondary bulbs nearer the surface than the mature ones. The secondary bulb, after reaching the depth of the flowering bulb, does not always blossom the next spring, for bulbs with six inches of soil above them have been found with one leaf each (fig. 8).

On May 30th the leaves had in most cases disappeared so that it was with difficulty that a few plants with fruit and decayed leaves were secured, while the soil was filled with the fleshy runners and newly formed secondary bulbs. These runners were often found on the surface of the soil, protected by the mulching of leaves. In such cases the new bulb is but very little, if at all, deeper in the soil than the parent.

The flesh of the mature bulb is firm and white, and leaves a white coating of starch on a knife with which it has been cut. When crushed between the fingers, it becomes sticky as it dries. The starch grains are about half the size of those of the potato, measuring from .010^{mm} to .042^{mm} in length and from .007^{mm} to .035^{mm} in breadth. The mature bulbs do not produce runners.

Plants frequently grow so close together that they indent each other, and adhere strongly one to the other, but no break in the skin at the point of contact was seen although looked for carefully. These clusters of bulbs are formed by buds which the mature bulb sends off from its base as was seen on November 4th, and in a very large one on November 30th. There was no runner present, but in other respects the bud corresponds to a secondary bulb, and comes to maturity in close contact with the parent. This budding is carried on for an indefinite period, two buds of different sizes sometimes being formed on the same bulb.

Plants examined in July, on September 18th, and on October 30th, showed no new developments except that the runners and the parent bulb had both disappeared save traces of the epidermis.

On November 1st, I examined, without a lens, a number of small bulbs which had been taken a couple of days before from just below the surface of the soil, in the same place in

which the runners were so plentiful on May 30th, and where blossoms had been abundant earlier. These small bulbs were not more than a quarter of an inch long, and, mistaking them for seeds, they were cut open in search of the embryo. They proved to be bulbs, for within each there was a sprout formed of the single leaf, extending the length of the bulb, and root fibers were clustered at the base.

These small seedlings had a loose husk or epidermis similar to that of the older ones, but not quite so dark in color. The mature bulbs had not softened since their time of blossoming early in spring. They were as firm on November 1st as on April 8th.

On November 4th a microscopical examination of sections cut from bulbs of various ages was made. A vertical section of a mature bulb showed a sprout of a yellow color, made up of several layers running up through the flesh near one side (figs. 21, 22). The outer of these layers was formed by the two foliage leaves enclosing the bud of next spring's flower. This flower bud was more than half as long as the whole bulb and its parts were well advanced. The perianth was nearly colorless, but the leaves were quite yellow. The stamens were nearly three-eighths of an inch in length, of which the anther was more than half. The anthers were filled with pollen, the grains of which were four times the size of the starch grains. The pistil was five-sixteenths of an inch in length, the ovary being one-eighth of an inch long. The projections on the placentæ from which the ovules are developed were seen and showed a dark center.

After removing the husk, the tip of a fresh specimen was seen to be made up of two modified leaves, or leaf scales, one completely surrounding the other except at the tip where the sprout and inner scale push through. The pressure on the edges of this opening compresses the flesh on the one side of the tip but makes it spongy on the other. These two tips, one within the other, gave the impression that the root is a true bulb, being formed of modified leaves, which was afterwards confirmed by studying the sections, and by comparison of the definitions of corm and bulb, and the examination of examples of each.

A section cut from the bulb a quarter of an inch below the tip showed the sprout to be composed of concentric layers which are the foliage leaves enclosing the perianth and other

parts of the bud. The epidermal cells were distinguishable at the middle of the outer leaf, which completely surrounds the inner one and overlaps, but the inner one does not meet around the enclosed flower-bud, as is shown in fig. 23. This is the character of the bulb scales, the outer one overlapping at the edges, which in its altered growth have united so that there is formed a continuous layer of very starchy flesh, which varies in thickness from one-sixteenth to three-sixteenths of an inch. The inner leaf and the inner scale agree in only partially surrounding the parts within it, and each is thinner than its outer fellow (fig. 18).

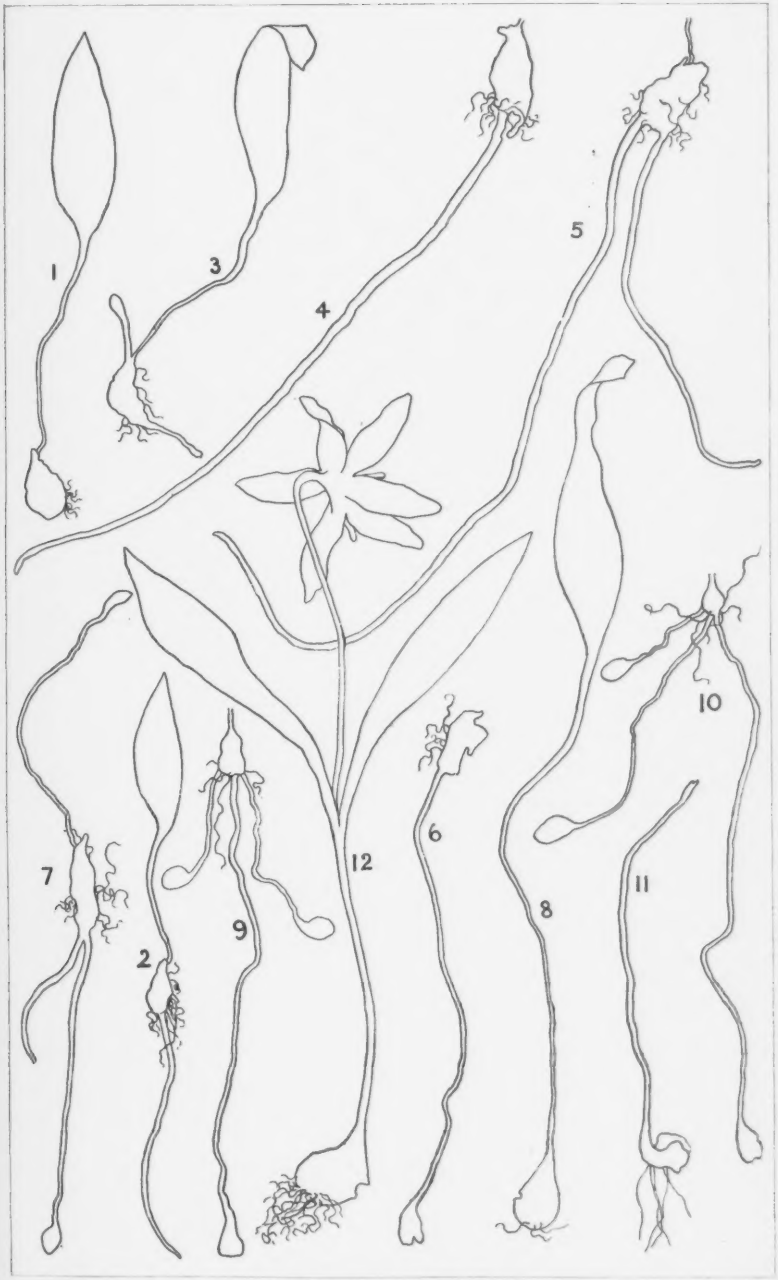
A second section showed each of the anthers to be composed of four pollen chambers, united by a delicate structure. The partition between the two in each of the lateral pairs of anther cells was thinner than that which separated these lateral pairs (fig. 24). In the later growth of the flower the thinner of these sets of partitions is broken through and thus each lateral pair becomes a single cavity forming "two-celled anthers" described in the manuals. In the center the three lobed style is seen in section. It shows the tube in each lobe through which the pollen is enabled to reach the ovules (fig. 23). These tubes of the style begin to expand, in a third section, into the cells of the ovary. The lateral pairs of anther cells have drawn away from each other and the partition separating the cells of each pair is thinner than in the previous section.

The edges of each sepal were turned inward at almost a right angle and indented the petals deeply, forming a groove on either side of the midrib of each petal. The petals in turn bent their edges inward, forcing them between the lateral pairs of anther cells on the alternate stamen (fig. 23). In the fourth section there is a more marked yellow tint to the perianth than before noticed.

The ninth section shows the line which marks the surfaces of the leaves which through modification form the pistil. On the involute margins of these leaves, forming the placentæ, the ovule masses appear, which are seen to be outgrowths from the edge of the leaf itself (fig. 25).

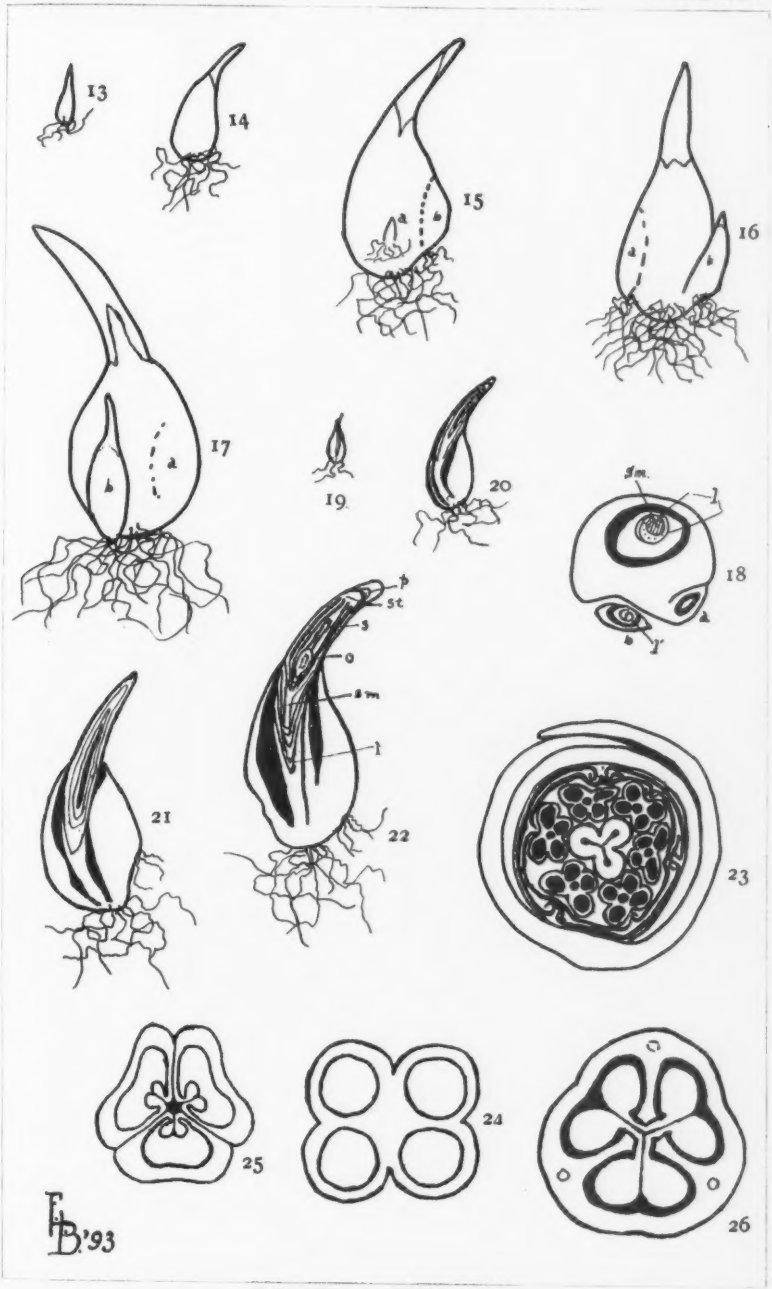
In the tenth section the union between the filaments and the midvein of the petals was clearly seen. The anthers do not adhere to the filament for their whole length as one of the filaments dropped away from the anther cells in this section.

An external bud, at the base of the bulb, contained a single leaf in a state of development corresponding to that of a bulb



BLODGETT on ERYTHRONIUM.

THE
JOHN CRERAR
LIBRARY



BLODGETT on ERYTHRONIUM.

THE
JOHN CREAR
LIBRARY

a quarter of an inch long. The upper surface of the leaf was marked by a line extending partly across the sprout.

On examining the bulbs a quarter of an inch long, from the seeds of last spring's flowers, the leaf was merely a round yellowish body having a line extending nearly across it, showing where the upper surface of the leaf was to be. In a bulb half an inch long, the leaf is convolute and its surfaces are free from each other. In an intermediate bulb, the leaf was convolute above and conduplicate near the base.

On November 29th a large bulb was found which had a bud almost entirely separated from the parent bulb, and there was also a bud forming at one side which had the sprout well developed but the line of separation was indicated only by a notch on one side. A similar bulb examined December 6th is shown in figs. 17 and 18.

Rutgers College, New Brunswick, N. J.

EXPLANATION OF PLATES VII AND VIII.

The figures of Plate VII are taken from blue prints which were made from pressed specimens. They are reduced a little more than one-half.

Fig. 1. Seedling plant in leaf.—Fig. 2. Seedling with growing runner.—Fig. 3. Seedling with runners started in opposite directions.—Figs. 4, 5. Runners in active state. Fig. 4 is 9 inches from base to tip, in a straight line; fig. 5 is 8 inches from base of longer runner to its tip, omitting bends.—Fig. 6, 7. Runners developing secondary bulbs.—Fig. 8. Plant with six inches of soil above the bulb, bearing one leaf and no flower.—Figs. 9, 10. Secondary bulbs formed at the ends of runners. The longest runner of fig. 9 is 7.25 inches long; the longest in fig. 10 is 7.75 inches long.—Fig. 11. Runner having rootlets from upper part of the secondary bulb. This runner grew at nearly the same angle as the one in fig. 4.—Fig. 12. Mature plant bearing two leaves and a flower.

The figures of Plate VIII were drawn directly from the specimens. The sprouts had developed so rapidly that some of the points seen on Nov. 4th had disappeared to a considerable degree, having grown from ¼ to ¾ of an inch in the month. The figures were made during the week ending Dec. 9th, from bulbs dug Nov. 29th.

Fig. 13. A seedling bulb.—Fig. 14. Secondary bulb showing sprout protruding.—Fig. 15. Mature bulb showing sprout, a small bud, *a*, and a larger bud, *b*, under the epidermis or husk.—Fig. 16. Mature bulb with one bud nearly separated, *b*, and another less advanced, *a*.—Fig. 17. Mature bulb with bud nearly independent of parent at *b*, and a second less mature one at *a*.—Fig. 18. Cross section of fig. 17; *l*, the bases of the leaves sheathing the stem, *sm*; *l'*, the single convolute leaf of bud *b*. The heavy black lines in this and the following figures are empty spaces between the flesh of the bulb and the sprout.—Figs. 19, 20, 21. Vertical sections of 13, 14, 15, respectively.—Fig. 22. Vertical section of mature bulb showing the flower; *p*, perianth, the tips of its lobes enclose the stamens, *st*, the style and stigma, *s*; *o*, ovary; *sm*, stem; *l*, bases of foliage leaves.—Fig. 23. Cross section of sprout showing the four celled anthers, the style, perianth and leaves. The anthers are distorted by pressure in the bud. ×3.—Fig 24. Cross sections of single anther. ×32.—Fig. 25 Section of ovary showing the lines which indicate the surfaces of the leaves from which it is developed, and the formation of ovules on the margins of these modified leaves. ×36.—Fig. 26. Section of older ovary. ×20.

Noteworthy anatomical and physiological researches.

The function of the secondary tissues in arborescent monocotyledons.[1]

The secondary growth in the aerial and terrestrial stems of the arborescent monocotyledons has already been studied by various authors, as for instance: Karsten, Millardet, Mirbel, Nägeli, Röseler and Wossidlo[2]. These investigations have been mostly restricted to the mere origin and development of the secondary meristem, while the study of the function of this tissue has been rather neglected.

The few authors, in whose works mention has been made of function, agree, however, in considering the secondary tissue as giving rise to a supporting apparatus for the stem, which often attains a considerable size in the Liliaceæ, for instance, *Dracæna* and *Cordyline*.

The structure of monocotyledons in which a secondary growth takes place exhibits two characteristic cases: the cells of the secondary tissues may become lignified as in *Dracæna*, *Cordyline* and *Lomatophyllum*, or their membranes may remain thin. There is no doubt that the first case shows a function of support, while in the other case an entirely different and highly important function is attributed to this thin-walled parenchyma. In *Cohnia flabelliformis*, for instance, the rhizome consists almost entirely of unlignified secondary parenchyma. These cells contain a considerable quantity of a fatty oil, which constitutes an important nutritive deposit especially for the development of adventitious buds. It is otherwise rare to find such deposits of fatty oils in the rhizomes.

A similar thin-walled parenchyma of secondary origin was also observed in *Yucca gloriosa*, especially in the rhizome; the cell-content was in this case a kind of sugar. *Dioscorea sativa* shows the presence of broad layers of secondary tissues, which form the principal element of the rhizome, as described by De Bary[3] as characteristic of other Dioscoreaceæ. The cells contained here large deposits of starch.

---

[1] De Cordemoy, Sur le rôle des tissus secondaires à réserves des monocotylédones arborescentes (Comptes Rendus **117**: 132. 1893).

[2] For citations see the original paper.

[3] De Bary, Vergleichende Anatomie der Vegetationsorgane der Phanerogamen und Farne 640. Leipzig, 1877.

The secondary mestome bundles, which have originated from the secondary parenchyma, serve naturally as carriers of such substances as are useful to the plant. This is very conspicuous in *Dioscorea*, where starch grains form heavy masses around the mestome bundles; this starch becomes transformed, however, upon the renewed growth in the spring. At this time it takes a reddish-violet color with iodine, and the grains near the mestome bundles have decreased in size and look as if they were partly digested. THEO. HOLM.

The role of the pericycle in the root of Dracæna marginata.[4]

The roots in certain monocotyledons show an increase in diameter, a fact that has been observed in *Aletris fragrans*, and in some species of *Dracæna*, e. g., *D. marginata*, *D. reflexa*, *D. fruticosa*, *D. Draco* and *D. rubra*. It has been demonstrated in most cases that the secondary parenchyma, to which this increase in diameter is due, is of a pericyclic origin. The cells of the pericycle divide tangentially and give rise to a secondary tissue with centrifugal development; some of these cells begin, thereupon, to divide in various directions and produce procambial strings, which soon become differentiated into a corresponding number of secondary mestome bundles. The central cylinder, therefore, is the structure which undergoes an increase in diameter.

Some cases have been recorded, however, where similar secondary formations were not of pericyclic origin, but developed in the bark. This fact was observed in *Dracæna reflexa* and *D. marginata* by Morot.[5] The pericycle had in these cases, nevertheless, preserved a certain activity, showing a few divisions of its cells.

Some analogous observations have been made by the author, who has studied the structure of the roots of *Dracæna marginata*. All the roots showed the presence of secondary formations in the bark itself. The pericycle had to a certain extent been multiplied, and had here a true mechanical function, not previously noticed. A transverse section of one of these roots, in which there is not yet any sign of secondary formations, shows an endodermis, the cell walls of which are

[4] DE CORDEMOY, Du rôle du péricycle dans la racine du *Dracæna marginata*. Bull. de la soc. bot. de France, **40**:— 1893.

[5] LOUIS MOROT, Recherches sur le péricycle. Ann. d. sc. nat. Bot VI. **20**: 217. 1885.

thickened so as to constitute a U-endodermis. Inside this is a simple pericycle, where some cells show a tangential division; the groups of leptome and hadrome border on this pericycle, as in other roots. But a root measuring about 72^{mm} in diameter shows that these tangential divisions of the pericycle do not produce any secondary parenchyma. There is, however, a secondary parenchyma present, but this is located in the bark, representing a secondary bark, of which the primary layers rest immediately upon the endodermis. The secondary meristem, from which these tissues have originated, has been formed in the innermost layers of the primary bark. When this secondary parenchyma developed in the bark, the pericycle commenced to show tangential divisions in various places, especially where it consisted of from seven to eight rows of radially arranged cells.

This increase of the pericycle causes a pressure from the interior to the exterior; thus the endodermis becomes ruptured in certain places, and a communication opens between the central cylinder and the cortical zone. The cells of the pericycle come to be, in this way, in contact with the secondary bark. These pericycle cells show, thereupon, a beginning sclerosis of their membranes.

The result of this investigation is that although the secondary formations in the root of *Dracæna* have originated from the bark, the pericycle may, nevertheless, show a certain activity, so as to produce a pressure from the interior to the exterior, by which action the endodermis becomes ruptured. A communication is thus established between the two conducting systems, the primary and the secondary.

THEO. HOLM.

Vegetable ferments.

There is hardly any branch of physiology which claims our attention more than that including the ferments. In the animals, as well as in the plants, their action is so important that it is impossible to form any opinion of the act of nutrition unless we keep a steady look at the ferments. Much has not been done yet, but it is a very desirable work that has been done by Professor J. R. Green,[6] namely, "to give some account of the various vegetable enzymes now known to ex-

[6] On vegetable ferments. Annals of Botany **7**: 83–137. 1893.

ist; to review their general properties, mode of action, and composition." He has also cited the literature of the subject extensively, for which the original paper must be consulted.

I. CARBOHYDRATE ENZYMES.

1. *Diastase.* Baranetzky found it in many plants, and it has been made the object for a special study by Kjeldahl, Brown and Morris, and others, especially in barley-seeds where it appears at an early stage of development and where it is found in the part of the endosperm adjoining the embryo, preparing the food for the latter out of the starch present in the grain. In leaves, its existence was known, and its function thought to be that of converting starch into sugar. Wortman, however, did not ascertain its existence, whence he concluded that the protoplasm had, itself, this function. Vines and St. Jentys gave afterwards new evidence of its presence and function. This so-called translocation-diastase will dissolve starch-grains without corrosion, has an optimum-temperature of 45°–50°C., and liquefies starch-paste slowly. Another form, viz., the diastase of secretion, was found by Brown and Morris, and Haberlandt; it is formed shortly after the beginning of the germination in the epithelium of the scutellum, dissolving starch-grains by corrosion. It liquefies starch-paste rapidly and has its optimum temperature at 50°–55°C. The final product of the transformation is apparently maltose, the intermediate members being unknown.

2. *Inulase.* In Dahlia, Helianthus tuberosus, and Inula Helenium, the reserve-material of the tubers is inuline, and a corresponding ferment, inulase, has been found.

3. *Invertase.* This ferment inverts cane-sugar into dextrose and levulose. It has been found in an extract of malt, in leaves and buds by Kossmann, in pollen-grains, in petals of Robinia Pseudacacia, in the embryo of germinating barley by Kjeldahl and O'Sullivan, and in several of the Saccharomyces, in Fusarum, and in Aspergillus niger.

4. *Cyto-hydrolytic enzymes.* These transform cellulose, where this is present as a reserve material, as in the seeds of Phœnix dactylifera. M. Ward has found that a similar enzyme is present in the hyphæ of Botrytis which was growing in the tissues of Lilium candidum. Also in germinating barley it has been found by Brown and Morris.

II. GLUCOSIDE ENZYMES.

1. *Emulsin or synaptase.* In certain species of Amygdalus, Cerasus and Prunus emulsin decomposes the amygdalin,

forming prussic acid and sugar: $C_{20}H_{27}NO_{11}+2H_2O=C_6H_5COH+HCN+2(C_6H_{12}O_6)$. Its place in the bitter almonds was studied by Johannsen and Guignard; the latter found it in special cells in the parenchyma of all parts of the plant; the greatest amount was, however, found in the seeds.

2. *Rhamnase.* In seeds of Rhamnus infectorius, it decomposes the glucoside xanthorhamnin into rhamnin and sugar.

3. *Erythrozym.*

III. PROTEO-HYDROLYTIC ENZYMES. Ferments of this group decompose proteids.

1. *Pepsin* is the most notable of these. Its presence in the fluid excreted by Drosera, Nepenthes, Dionaea, Pinguicula, Sarracenia, etc. is well known, as well as the theories based upon these facts, and also the lately announced Russian experiments.[7] A peptonizing ferment was also found by Krukenberg in Æthalium septicum.

2. *Tryptic enzymes.* In Carica Papaya one of these, the papain, has been observed; in the fruit of the pine-apple, Chittenden found another enzyme of this group. In the seeds of the vetch Gorup-Besanez found an enzyme, and also in the seeds of flax, hemp, and barley, while Green worked with the lupines. How these ferments work *in the plants* has not yet been satisfactorily investigated.

3. *Rennet.* In Galium verum, a substance was long since noticed which was able to coagulate milk. Afterwards, an enzyme was found in Pinguicula vulgaris by Linné and Darwin, in Withania coagulans (seeds) by Lea, in Datura Stramonium, Pisum sativum, Lupinus hirsutus, and Ricinus communis, by Green. We may add that rennet has also been isolated from bacteria by Conn.[8]

IV. GLYCERIDE ENZYMES. Such are able to decompose oils or fats. Müntz was the first who paid attention to the splitting up of the oils in germinating seeds. In Ricinus communis an enzyme was found; it decomposes fats into fatty acids and glycerin. In many other seeds of this group similar enzymes have been noticed.

In many fungi and bacteria, enzymes are present. Five distinct enzymes were found by Vignal in the Bacillus mesentericus vulgatus: diastase, invertase, rennet, and a proteohy-

[7] BOT. GAZ. **18:** 105. 1893.

[8] Science (New York), 1892, 253. Fifth Report of the Storrs Agr. Exp. Station, 1892. 106.

drolytic as well as a pectic enzyme. The enzymes of the pathogene bacteria are subjects of a great deal of study, and much has been written on them.

Zymogens ("mother of ferment") are known from the animals. They have been found in plants, such as Nepenthes, in resting wheat grains, in the irritable cells of Dionaea muscipula, and in others.

A discussion of the constitution of the enzymes, the many theories with reference to their mode of action, etc., forms the conclusion of Professor Green's solid work.—J. CHRISTIAN BAY.

Equiseta in the carboniferous.[9]

It is now about nine years since MM. Renault and Zeille[10] published from the Commentry basin, upper coal measures, a description and figure of an Equisetum stem about 12^{cm} long and 4 or 5^{cm} wide, showing thirteen nodes which are provided with unquestionable toothed sheaths in the arrangement characteristic of *Equisetum.* This *Equisetum Monyi* constitutes perhaps the first really good evidence of the presence of the genus in the carboniferous, though a number of unsatisfactory species of *Equisetites* were published years ago by older authors. This evidence is now essentially corroborated by the description and illustration, by Mr. Kidston, of several fructifications which, although the under sides of the hexagonal sporangiferous shields with the sporangia cannot be seen, are so nearly identical in every character with the cones of *Equisetum limosum* Sm. as to leave almost no room for doubt as to the existence of the actual genus as far back in geological time as the carboniferous. The specimens are from the shale in the Barnsley thick coal, in the middle coal measures of Yorkshire, England.—DAVID WHITE.

The mechanics of growing plants.

While Charles Darwin, Krabbe, Clark and others have brought to light many important facts bearing upon the work accomplished by plants in growth and movement, yet to Dr. Pfeffer must belong the credit of the formulation of the gen-

[9] ROBERT KIDSTON; On the occurrence of the genus Equisetum (*E. Hemingwayi* Kidston) in the Yorkshire coal-measures. Ann. and Mag. N. H., F. 1892. 138–141.

[10] Comptes Rendus, 5 Ja 1885. Études sur le terr. houill. Commentry.—Flore fossile 2: 394. *pl. 57. f. 7.* St. Etienne, 1890.

eral principles governing the performance of work, and the establishment of the relations between inner and outer manifestations of energy in the growing plant.[11] The subject received its first important consideration from him in his "Pflanzenphysiologie" (**2**: 1. 1882), and later an exhaustive and critical discussion in his "Energetik der Pflanze" of which the memoir before us is an extension, together with the results of a series of close experiments on roots, seedlings, grasses, and algæ.

Plants were encased in gypsum casts rendered isosmotic by an admixture of nitrate of potassium or sulphate of magnesium. Others were enclosed in clay and in gelatine. While thus held firmly, longitudinal and transverse pressures delivered by various organs were measured directly by simple and ingenious dynamometers constructed for the purpose.

The results of these experiments are of the deepest interest. In the growing tips of roots of *Faba vulgaris* an elongating pressure of five to ninteen atmospheres was measured. In roots of *Zea mais* a similar force of nine to twenty-four atmospheres was observed; in *Vicia sativa*, eight to thirteen atmospheres, and in *Æsculus hippocastanum*, six atmospheres. The transverse pressure delivered by roots of *Faba vulgaris* amounted to two to six atmospheres; by *Zea mais* 6.59 atmospheres.

The power of geotropic curvature was found to reside in the nodes, internodes and basal portions of the leaves in various species of the grasses. The turgor producing this curvature amounted to six to thirteen atmospheres.

In the case of transverse tensions, however, the total pressure was far greater than that exerted by the longitudinal tensions. All externally expressed tensions are set up in the same manner as the tissue tensions. In this connection a large amount of valuable matter concerning turgor, and its methods of analysis by plasmolysis are given.

Perhaps the most remarkable facts recorded in the paper are the accounts of experiments in which Spirogyra, Chara, and Nitella were grown for several weeks embedded in the plaster casts, without injury to their organization.

The notable lack of literature on the subject matter enhances if possible the value of this and the preceding memoir.

[11] W. PFEFFER: Druck- und Arbeitsleistungen durch wachsende Pflanzen. Abhandl. d. math.-phys. Classe d. Königl. Sächs. Ges. d. Wiss. **20**: — no. 3, 1893.

Taken together they form a comprehensive reference text, which by its lucid exposition, and simple methods of experimentation, will be useful as a laboratory manual in directing further research on this phase of plant life. As such it is available to any worker with even an elementary knowledge of the subject. The matter has a twofold importance; because of its connection with the physiology of the plant, and because through it only are the facts of mechanique capable of their true interpretation.—D. T. MACDOUGAL.

CURRENT LITERATURE.

The Buitenzorg Botanic Garden.

Botanic gardens are not common in America, and moreover their usefulness is not generally recognized. From an economic and commercial point of view they are not considered of sufficient value to pay for their maintenance. Even from the purely scientific side of the subject the opinion is by no means unanimous that they are worth as much as they cost. There are good and sufficient reasons for this state of affairs, which, however, need not be rehearsed in this connection. Recently some indications of a change in popular and scientific sentiment have been apparent, encouraged especially by the prominence and acknowledged success of the Missouri Botanic Garden. Probably the botanical public has never been more ready to learn about botanic gardens, their history, their aims, their resources, than now. The recent appearance of the memorial volume[1] commemorating the seventy-fifth anniversary of the founding of the botanic garden at Buitenzorg, Java, is therefore opportune.

The memorial volume was first published in Dutch, but has been translated into German, and a dozen handsome views of the garden added, for the convenience of European botanists, a form that will also, no doubt, be acceptable on this side of the Atlantic. The volume contains, as an introduction, the anniversary address of Dr. M. Treub, the director, upon the "value of a tropical botanic garden," and also very interesting articles giving a history of the garden, description of a stroll through the garden, an account of the herbarium and museum, a descriptive and classified list of the scientific investigations conducted at the garden, and an account of the more important economic plants cultivated, as well as several lists of plants, books, visiting investigators, etc., prepared by the several members of the garden staff. Nearly the whole volume will prove of much interest to botanists in general, quite apart from its local application.

The seventy-five years (now nearly seventy-seven years), of existence of the Buitenzorg garden have seen great changes in its fortunes. Founded in 1817 to secure, test and distribute seeds and cuttings of useful plants to the Dutch colonies, it flourished for nearly a decade, then for a dozen years was reduced to inactivity and nearly abolished

[1] Der botanische Garten, "'s Lands Plantentuin," zu Buitenzorg auf Java: Festschrift zur Feier seines 75-jährigen Bestehens (1817–1892). Leipzig, Wilhelm Engelmann, 1893. Roy. 8vo. 426 pp. 12 photogravures. 4 maps. M. 14.

through political influence. In 1830 a young gardener, twenty years of age, Mr. J. E. Teijsmann, without scientific training, but with great energy, perseverance and sound judgment, was placed in charge. For more than half a century he directed the fortunes of the garden, raising it from a state of lethargy to one of usefulness, and causing it on the whole to make wonderful development, although through political and other misfortunes it several times met with disheartening reverses. In 1844 the large and important herbarium was ordered to be sent to Holland, to the Royal Herbarium at Leyden, a loss to the garden still felt in the study of the native flora, although the present collection is very large.

The library possesses about 2,400 volumes, more than half being exclusively botanical, also 165 periodicals. Large collections of vegetable products of various kinds form an attractive museum for study and instruction. The garden covers 144 acres, and abounds in beautiful landscape effects, noble trees, and a wealth of tropical plants, numbering over 9,000 species. The principal buildings are the museum, the agricultural-chemical laboratory, the pharmacological laboratory, the studio for photography and engraving, the large botanical laboratory (where visiting botanists work), and the offices and small botanical laboratory. The staff consists of fifteen members beside the director; the labor of caring for the garden is performed by about 200 native Javanese.

Although the garden was founded and has been maintained for practical ends, it has of late years attained a high reputation for its scientific researches, partly published in the *Annales* of the garden, and partly elsewhere. The present management has provided facilities for visiting botanists, the laboratory for their use being opened in 1885, and encourages the freest use of the same. The visiting list is already long, including many well known names, such as Professors Solms-Laubach (Strassburg), Goebel (Munich), Tschirch (Berlin), Schimper (Bonn), Stahl (Jena), Haberlandt (Graz), and others. The favorite time for a visit appears to be from November to March, although some visitors are likely to be found in the laboratory at all times of the year.

This notice is given for the purpose of calling attention both to a valuable and attractive book, and to a tropical laboratory where American investigators will find a hearty welcome and rare facilities for study of vegetation under the tropics.

Botany of the Death Valley Expedition.

This report not only deserves notice for its own sake, but also as representing the result of the first attempt by the government to conduct a biological survey from the botanical standpoint. The result certainly indicates the great advantage of having trained botanists as well as collectors in the field. Compared with the usual bare lists, with such meager information as collectors have made possible, the present report belongs to an entirely different class. Mr. Coville is known to be very systematic, and the parts follow each other with all the precision and fulness of an encyclopedia. The summary shows that the catalogue contains 1,261 species and varieties, forty-two of which are characterized as new. Two genera are proposed as new, viz.: *Orochænactis* (founded upon *Chænactis thysanocarpha* Gray) and *Phyllogonum* (a peculiar member of the Eriogoneæ). *Fremontodendron* is proposed as a substitute for *Fremontia* under the rule of homonyms. As interesting as is the catalogue of species, with its very full and very valuable notes, the most significant part of the report is that which deals with the principles of plant distribution in general, the distribution of plants in southeastern California, and the characteristics and adaptations of the desert flora. The treatment of the general subject of distribution is best indicated in the following summary given by the author:

"To sum up, the six ultimate factors in the distribution of vegetation are heat, light, water, food, air and mechanique. These factors are variously combined in actual fact into such conditions, among others, as geographic isolalation, latitude, altitude, rainfall, soil, fires, proximity to large bodies of water, slope exposure, and presence of forests."

Attention is called also to the fact that trees and shrubs are the best zonal guides, as illustrated by the Larrea zone (Lower Sonoran), in which occurs a Grayia belt. In treating of the distribution of plants in S. E. California, the desert plants east of the Cordilleran system are considered, the plants of the high Californian Sierras (which were found to show as close an affinity to those of the Rockies of Colorado as to those of the Oregon and Washington Cascades, which is taken to indicate a former boreal communication across Nevada and Utah), and those of Death Valley proper. The last show, what was to be expected, a northern extension of Sonoran and Chihuahuan types. The characteristics and adaptations of the desert flora

[1]COVILLE, FREDERICK VERNON:—Botany of the Death Valley Expedition. A report on the Botany of the Expedition sent out in 1891 by the U. S. Department of Agriculture to make a biological survey of the region of Death Valley, California. 8vo. pp. 318, with 21 plates and map. Contributions U. S. Nat. Herbarium, Vol. IV, 1893.

is a subject so full of interest that it cannot fairly be treated in our limited space. There is presented the source and distribution of moisture, the conservation of moisture, the temperature and seasons of the region, a classified list of the desert plants, and general and special adaptations. Under general adaptations the absence of trees is noted, and the size, spacing, and form of the characteristic shrubby vegetations in their relation to each other and the struggle for moisture. The marked special adaptations are also to be found chiefly among the shrubs, as the plants "subjected to all the seasonal changes of many years." Naturally these special adaptations have to do chiefly with modifications for reducing transpiration, and also rapid radiation, and quite a list of plants is given with the modification in each case. This part of the report, however, deserves careful reading, and the whole stands as the most important one of the Contributions of the National Herbarium yet issued. It is also a matter of great congratulation that the twenty-one plates accompanying the report are of the best quality and not the rough ones that have been too common in the "Contributions."

A Flora of French Polynesia.[1]

Any account of the plants of the Southern Pacific is looked to with interest. The book before us is a regular manual, and looking through its pages at once suggests a strange flora to one chiefly acquainted with north temperate regions. The structure of the islands, their topography, and the conditions of climate are described. All combine to favor a luxuriant vegetation, one more brilliant than varied, and chiefly remarkable for the number of individuals. The great display of evergreen and suffrutescent species is noted, followed by trees and shrubs, the annuals representing a very insignificant part of the vegetation. The largest families, in the order of their importance, are Ferns, Leguminosæ, Orchidaceæ, Rubiaceæ, Gramineæ, Cyperaceæ, Euphorbiaceæ, and Urticaceæ. The usually dominant family of Compositæ is feebly represented, but it is interesting from the woody and arborescent forms it contains. The author considers the Polynesian Compositæ to be American in their affinities. The species of French Polynesia can be thrown into three categories, (1) those that are peculiar to it, (2) those which it has in common with Oceanica exclusive of Malaysian flora, (3) those in common with the Indo-Malaysian region. The first group contains 28.9 per cent. of the flora, the second 20.8 per cent and the third more than the other two combined. The number of species described is 744, of which 144 are ferns.

[1] Del Castillo, E. Drake:—Flore de la Polynésie Française, description des plantes vasculaires qui croissent spontanément ou qui sont généralement cultivées aux iles de la Société, Marquises, Pomotou, Gambier et Wallis. 8vo. xxiv. 352, with colored maps. Paris. G. Masson. 1892.

Minor Notices.

PROFESSOR L. H. PAMMEL, in connection with an account of Sclerotinia libertiana, has published a very valuable bibliography of fungus root diseases, containing considerably over 500 titles. The paper appears in Trans. St. Louis Acad. 6: 191–232. 1893.

JUNCUS MARGINATUS and its varieties are discussed by Mr. F. V. Coville in a recent excerpt from Proceedings of the Washington Biological Society. The forms of this widely variable species have been variously treated. Mr. Coville separates the species into three forms, characterized as *J. marginatus* (type form), *J. marginatus aristulatus*, and *J. marginatus setosus*, the last of which has never happened to be characterized. Some useful suggestions are also made as to the treatment of such groups.

MR. WILLIAM E. MEEHAN'S "Contribution to the flora of Greenland" has been distributed as a reprint from the Proceedings of the Philadelphia Academy. As is well known, this reports the botanical results of the Peary expedition, the collections being made by Messrs. Burk and Meehan. Just 100 species of phanerogams and pteridophytes are enumerated. The profusion of lichens and mosses is remarked, thirty-nine species of the former, and twenty-eight of the latter being noted.

THE REPORTS of the State Botanist of New York for 1891 and 1892 are just at hand. The former contains a revision of the New York species of *Omphalia*, twenty-one in number, besides the descriptions of seventeen new fungi. The latter contains an account of the New York species of *Pleroteolus* and *Galera*, besides the descriptions of thirty-seven new fungi. It is stated that forty quarto plates of edible (59 species) and poisonous (3 species) mushrooms have been prepared, drawn full size, in color. These are ready for publication, together with suitable explanatory text. Their early appearance will delight all mycologists and mycophagists.

DR. WM. TRELEASE has been studying the winter condition of our maples, and also the confused sugar maples.[1] The treatment of the sugar maples has been so various that the synonymy is badly tangled. Dr. Trelease recognizes three species of the group SACCHARINA, namely, *A. saccharum* Marsh. (*A. saccharinum* of the Manual) with its varieties *barbatum* (*A. barbatum* Michx.) and *nigrum* (*A. saccharinum*, var. *nigrum* of the Manual); *A. Floridanum* Pax., with its variety *acu-*

[1] TRELEASE, WILLIAM:—Sugar maples, and maples in winter. Reprinted in advance from the 5th Ann. Rep. of the Mo. Bot. Gard. pp. 20 with 13 plates. January 1, 1894.

minatum; and *A. grandidentatum* Nutt. All these forms become varieties of *A. barbatum* in Sargent's Silva. This part of the contribution is illustrated by ten plates. The second part presents a winter synopsis of all North American maples, and with the help of three plates not only shows the possibility of determinations in the winter condition, but also develops new specific characters.

PROFESSOR S. C. MASON has published in the Eighth Biennial Report of the State Board of Agriculture a preliminary report upon the variety and distribution of Kansas trees.

DR. J. H. WAKKER opens a series of reports from the East Java Experiment Station[1] consisting of articles extracted from the archives of the Java Sugar-Industry, and treating of the diseases of sugar-cane and the improvement of cane by use of seed.

TWO PAPERS upon the flora of Wisconsin have been issued in the ninth volume of the Transactions of the Wisconsin Academy, and separates were distributed in advance of publication of the volume. These are "A preliminary paper on the flora of Dane county," by L. S. Cheney and R. H. True, and "A supplementary list of parasitic fungi of Wisconsin," by J. J. Davis. The first is prefaced by a brief account of the climatic and geologic conditions of the range covered and accompanied by a topographic map reproduced from the sheets of the U. S. G. S. It includes spermaphytes, pteridophytes and bryophytes. The second paper is supplementary to Trelease's list of the fungi of Wisconsin prepared in 1882.

THE SERIES of bulletins from the laboratories of natural history of the state University of Iowa has just now reached the close of the second volume. The current number contains ten papers, six of which are botanical. Mr. B. Shimek gives a full account of the botanical expedition to Nicaragua, which seems to have been very successful in the collection of material and notes; Professor McBride furnishes four numbers, namely, an account of the Nicaraguan Myxomycetes (which are strikingly like those of the northern United States, of the twenty-five species collected nineteen being identical with those commonly found in eastern Iowa, and the six new ones representing familiar genera), a continuation of the presentation of the myxomycetes of eastern Iowa (nine species, two of them being new), the description of a new Physarum from Colorado, and the description of a new fossil cycad (Bennettites) from the Jura-Trias of S. Dakota; and

[1] Mededeelingen Proefstation "Oost-Java." Nieuwe Serie. Roy. 8vo. Soerabaia 1893. No. 1, De bladziekten te malang, 7 pp. No. 2, Djamoer oepas op arrowroot en andere planten, 6 pp. No. 5, Onze zaadplanten van het jaar 1893, 13 pp.

Mr. Chas. L. Smith presents a synoptical view of Central American Pyrenomycetes, with descriptions of new species.

ANOTHER ONE of the "Contributions from the U. S. National Herbarium", being no. 8 of vol. I, has lately appeared, being of special interest as containing all the unpublished botanical manuscript of the late Dr. George Vasey, except that which had been prepared for the concluding part of his Monograph of the Grasses of the United States and British America. This material appears under the titles "Notes on some Pacific Coast Grasses" (in which 8 species are considered), "Descriptions of new or noteworthy grasses from the U. S." (in which over 30 new species are described, 17 of which belong to *Poa*), and "Descriptions of new grasses from Mexico" (16 in number). In addition to these numbers, Mr. J. M. Holzinger describes four new species from Texas and Colorado, and gives a list of 17 plants, new to Florida, collected by J. H. Simpson; Mr. J. N. Rose describes 3 new plants; and Mr. J. W. Eckfeldt gives a list of 42 lichens from California and Mexico, collected by Dr. Palmer from 1888 to 1892.

"BULLETIN of the Maine State College Laboratory of Natural History" is the descriptive title of another local publication to be issued at irregular intervals. The opposition of the GAZETTE to the multiplication of serials of an uncertain life tenure and limited distribution is well-known. The present instance appears less objectionable than usual, as the number before us (Vol. I, no. 2) contains only matter of local interest. It is dated January, 1893, although the number reached us only last month (Jan. 1894). It consists of two bare lists with localities, both prepared by F. L. Harvey and E. P. Briggs, one of the phanerogams and vascular cryptogams of the Blake Herbarium, "as it came to the college" (the only information descriptive of the collection), enumerating about 3,500 species, and the other of the phanerogams and vascular cryptogams of the state, principally from the vicinity of Orono, the college town, numbering less than a thousand species.

OPEN LETTERS.

Acknowledgment.

In my article in this journal, 18: 455, entitled *Studies in the biology of the Uredineæ*, I have described an unusual method of formation of sporidiola, and stated that so far as I knew, it had been unobserved before. I have since discovered (soon after my article was in print) that Dr. Farlow refers briefly to this phenomenon in *Gymnosporangia of the United States* 9, and there cites Cramer also, who mentions the same process in *Ueber den Gittterrost der Birnbäume und seine Bekämpfung*, in Schweizer landw. Zeitschrift 1876. 7, as occurring in the germination of *Gymnosporangium*. Moreover, Dr. Farlow mentions the *germination* of these sporidiola, which I have not *certainly* observed, although, in one culture, one individual seemed to be germinating. He also tells me that Dr. Thaxter mentions the same process in his paper *On certain cultures of Gymnosporangia*, in Proc. Acad. Arts and Sci. 1886, 260, which paper I have not yet seen. I have carried on rather extensive cultures of *Gymnosporangium* (with two species, *G. macropus* and *G. globosum*), but have never yet observed such phenomena in that genus. I have already mentioned, in footnote ten of my article (l. c.), Lagerheim's observations with LEPTOPUCCINEÆ, but further experiments are necessary to establish the identity of the phenomena observed by him with the process I have described. There is a very marked error in this reference. The words "in which I do not find this process" should read "which is not true of my observations."—M. A. CARLETON, *Kansas Experiment Station, Manhattan.*

NOTES AND NEWS.

MR. R. BENTLEY, emeritus professor of botany in King's College, London, died December 24, 1893.

MR. JOHN DONNELL SMITH sailed February 10th for another visit to Central America, whose flora he is so energetically investigating.

DR. RICHARD SPRUCE, the well-known English traveler, collector and hepaticologist, died at his home at Coneysthorpe on the 28th of December, at the age of seventy-six.

MR. G. H. HICKS, instructor in botany in the Michigan Agricultural College, has been appointed assistant botanist in the Division of Botany of the Department of Agriculture.

MR. ALBERT F. WOODS, assistant in botany in the University of Nebraska, has been appointed assistant pathologist in the Division of Vegetable Pathology of the U. S. Department of Agriculture.

IN THE ABSENCE of Prof. V. M. Spalding from the University of Michigan for a year's study in Germany, Mr. F. C. Newcombe, who returned from Europe last summer, has been placed in charge of the instruction in botany.

DR. E. BONAVIA has been trying to identify the plants of the Assyrian monuments. In some cases the identification seems to be sure enough; in others the representations are so conventional as to give rise to large diversity of opinion.

NOTICE has been received of the death of Rev. Samuel Lockwood, Ph. D., of Freehold, N. J., which occurred January 13th. Professor Lockwood was an ardent naturalist and a very ready writer. He was one of the first subscribers to the GAZETTE, and made several contributions to its earlier volumes.

OF THE ANNUAL REPORTS of experiment stations for 1892 two are especially interesting for their botanical matter: Vermont and New Jersey. The former contains fifty-five pages on plant diseases, by L. R. Jones, and the latter 112 pages on plant diseases and weeds, by B. D. Halsted. Both reports are well illustrated.

HEDWIGIA appears in an enlarged and somewhat altered form. Each bi-monthly part is to consist of 64–80 pages, with 2–3 plates. The original articles are to be paged separately from the abstracts of cryptogamic literature, and will occupy from 16–32 pages. The price is increased from eight to twelve marks.

IT SEEMS that the "Russian thistle" (*Salsola Kali* var. *Tragus*), which has proved so destructive in South Dakota is threatening to spread over Nebraska. Bulletin 31, of the Agric. Exp. Station of Nebraska, prepared by Dr. Bessey, deals with the subject, giving an account of the structure of the plant and suggestions as to co-operation for its eradication.

In the Linnean Society's Journal (30: 51), the first paper by Mr. J. C. Willis, under the title, "Contributions to the Natural History of the Flower" appears. It discusses the fertilization of *Claytonia* (two species), *Phacelia* (five species), and *Monarda* (three species), and is illustrated by one plate. It seems that the writer is presently to visit the western United States, where some of the species of the paper and others can be studied in their native haunts.

The prize of 500 francs, founded by Augustin-Pyramus de Candolle will be awarded by the Société de physique et d'histoire naturelle de Genève for the best unpublished monograph of a genus or family of plants submitted through the president, M. Ch. Soret, before January 15, 1895. The manuscripts may be written in Latin, French, German (Roman letters), English or Italian, and the society will publish the accepted one in its quarto memoirs if agreeable to the author.

Iowa Agricultural College has recently purchased the Parry Herbarium and Library for the sum of $5,000, which it hopes to make of service to the working botanists of this country. This collection was brought together by Dr. C. C. Parry, who died in 1890. It is especially rich in West-American plants. The specimens are in excellent condition and with the 25,000 specimens now in the college collection there is an abundance of material for a large herbarium.

On the eighth of December, 1893, Professor Dr. Jacob George Agardh celebrated in Lund, Sweden, his eightieth birthday. On this occasion Prof. Dr. J. B. De Toni, on behalf of a large number of phycologists, presented to the distinguished Swedish algologist, an artistically gotten up address with the signatures of all those taking part therein. The simple text of the address runs: "Clarissimo phycologo —J. G. Agardh—ineunte aetatis suae anno octuagesimo—(8. Dec. MDCCCXIII—MDCCCXCIII)—gratulantes offerunt aestimatores." —Bot. Centralb. 57: 96. 1894.

Mr. A. D. Hopkins, entomologist of the West Virginia Agricultural Experiment station, has ready for printing the manuscript and illustrations for a popular bulletin on "Defects in wood caused by insects," and "Black holes in wood." The bulletin will contain over forty figures from original drawings and photographs from nature, with accounts of the characters of the defects and the insects causing them; simple and inexpensive methods of preventing the occurrence of certain kinds, together with other matter intended to be of interest to the general reader. It will be sent free to those requesting it.

In the *Bulletin of the Torrey Botanical Club* (Dec.) Mr. John K. Small gives an account of the altitudinal distribution of the ferns of the Appalachian mountain system, representing a kind of work in geographical distribution that deserves much careful attention. In addition to the stations, with their elevations, each species, following the lines of Allen's Geographical Distribution of N. Am. Mammals, is referred to one of four faunal areas, viz.: Canadian, Alleghanian, Carolinian, and Louisianian. In the same number Dr. Thomas Morong gives some interesting results of his studies among monocotyledons.

DROPSICAL DISEASES of plants constitute a new class of maladies brought to light within a year by Prof. Geo. F. Atkinson, of Cornell University. He writes in *Science* (Dec. 15, 1893), of tomatoes and apples thus affected; and in *Garden and Forest* of a later date (Dec. 27, 1893), adds an account of violets grown in forcing houses, which suffered severely in a like manner. In the last case the small veinlets on the under side of the leaf show little swellings, which finally dry up, the leaf gradually turns yellow and dies. An instance is cited where all the plants of a large establishment lost their leaves from this cause, and became worthless.

THE BOTANICAL SEMINAR of the University of Nebraska has undertaken the publication of a "Flora of Nebraska," in which the entire flora of the state is to be described. The work will appear in twenty-five parts, not more than three or four in any one year, and will cost one dollar a part. Illustrations are to be freely used to illustrate the lower groups and the more difficult phanerogams. While the prospectus is apparently addressed to students of botany in Nebraska it is of decided general interest, as it not only represents an effort unique in this country, but deals with one of those "middle regions" that have never had fair treatment at the hands of manuals.

IN THE *Journal of Botany* (Jan.) Mr. F. N. Williams discusses the primary subdivisions in the genus *Silene*. He points out the "inconvenience of regarding the mode of præfloration in the petals as a primary character." The primary divisions he bases on the structure of the calyx, slightly modifying Rohrback's arrangement, and follows Engler and Prantl in regarding each division as a subgenus, of which three are recognized. The delimitation of the genus by the character of a unilocular capsule septate at the base transfers many of the North American species to the genus *Melandryum*.

IN THE Proceedings of the Cambridge (England) Philosophical Society (8: part 2), Messrs. J. C. Willis and I. H. Burkill give the results of observations on the flora of the pollard willows near Cambridge. The willows were polled at a height of eight feet, and stood in rows a few yards apart. Their tops contain large masses of humus, in which occur many plants. No less than eighty species have been found growing in this situation. In abundance of occurrence *Galium Aparine* heads the list, followed by *Sambucus* and *Rosa*. *Urtica* and *Cratægus* are also common. Questions as to the mechanism of seed distribution are suggested. The fact that birds' nests are common in willow tops led to an investigation also of the plants used in building.

AT THE EIGHTH annual session of the Iowa Academy of Sciences, the following botanical papers were read: T. H. McBride: Notes on the North American Cycads, and The distribution of *Rhus typhina;* S. Calvin: On the geological position of *Bennettites dacotensis* MacBride, with observations on the stratigraphy of the region in which the species was discovered; A. C. Spencer: A Mazon flora in Iowa; Mary A. Nichols: Observations on the pollination of some of the *Compositæ*; B. Fink: Some additions to the flora of Iowa; L. H. Pammel: Powdery mildew of the apple, Farther notes on *Cladosporium carpoph-*

ilum Thüm., and Notes from the botanical laboratory of Iowa Agricultural College. The presidential address was also given by Prof. Pammel, the subject being: Bacteria; their relation to modern medicine, the arts and industries.

THE EDITORIAL PLEA for more attention to physiological research in the state agricultural experiment stations, given in a recent number of *Experiment Station Record* (5: 270–271), is to be heartily commended. A few sentences may be quoted here: "The systematic investigation of the physiology of particular species of plants throughout their life history is greatly needed. The practical, as well as the scientific, importance of such researches in the case of cultivated plants is very great. It is true that physiological inquiries, whether on plants or animals are difficult to carry on. However these things which are hard to find out are the very ones our institutions for experimental research should seek after. Wherever opportunity offers laboratories should be equipped and trained workers employed for investigations on the physiology of cultivated plants."

IN THE *American Naturalist* (Jan.) Dr. Chas. E. Bessey presents a synopsis of the larger groups of the vegetable kingdom. This synopsis, in chart form, had already been distributed and welcomed in our laboratories. The slime moulds have been excluded, as more properly belonging to the animal kingdom. The "classes" are those usually recognized, but in the first two the limits have been slightly extended. The groups below classes are tentatively called "orders," and as the orders of the lower plants are found to be equivalent to the "series" of Bentham and Hooker, the former term is made to supplant the latter, and the so-called "orders" of the manuals become simply "families." Of course the group of "Apetalæ" is not kept separate, and apocarpous and hypogynous characters are regarded as primitive and lower than the syncarpous and epigynous condition. The six "branches" are Protophyta (fission algæ, including bacteria), Phycophyta (green and brown algæ), Carpophyta (the old "spore-fruit" group), Bryophyta, Pteridophyta, and Anthophyta.

THE RADIATION AND ABSORPTION of heat by leaves has been studied by A. G. Mayer (Am. Jour. Science 45: 340–346. 1893). He found that the leaves of ash, elm, maple, cherry, horse chestnut, lilac, mullein, burdock and chicory absorb from 77 to 86 per cent. of heat falling upon them, and transmit from 14 to 23 per cent. The radiation is the same as the absorption. Variations are largely due to individual differences of the leaves of the same species, there being little difference between species of even widely separated genera, or between species with very different texture of leaves. Thus, the leaves of maple and mullein are essentially alike in their relation to heat. The petals of rose and other flowers transmit much more heat, and retain less, than leaves. The upper and lower surface of leaves were not found to differ in their behavior toward heat, with the single exception of burdock, which radiates but four-fifths as much from the lower as from the upper surface. Leaves are among the best absorbers and radiators of heat known. A coating of dew over the surface, however, will reduce the radiation by one-third.

AT A RECENT meeting of the botanical section of the Schlesische Gesellschaft für Vaterländische Cultur, Dr. Ferdinand Cohn spoke on formic aldehyde and its effect on bacteria. Among other interesting matters he called attention to Hauser's method of permanently fixing gelatin tube and plate cultures of bacteria by vapor of formic aldehyde, obtained by pouring a few drops of the solution on cotton. Microscope preparations may be then made by cutting out little pieces from such plate cultures. The permanence of these fixed cultures depends on the formation on contact with the vapor of a solid and hard modification of gelatin, which is not fluid at any temperature. Gelatin liquefied by bacteria is also rendered solid, while retaining the optical appearance of its fluid condition.

Cohn also found that very dilute watery solutions of formic aldehyde preserve plant tissues and organs, as well as the delicate algæ perfectly. The blackening often occasioned by alcohol is not produced, and the green color is completely preserved. The permanence of these materials can only be known after longer tests than the six months which these have continued. The addition of 15–20^{ccm} of the commercial 40 per cent. solution to a liter of water makes a solution of preservative strength. In working with formic aldehyde care must be exercised, as its vapor produces severe headache and irritates the mucous membranes.

THE Geological and Natural History Survey of Minnesota is organized upon a very liberal basis, especially favoring exploration and publication. The Bulletins, issued from time to time, have contained much valuable material. The state botanist, Professor Conway MacMillan, now proposes to publish Bulletin no. 9 in parts, under the title, "Minnesota Botanical Studies," until a volume is completed. The first part (Jan. 16, 1894), contains the following papers: "On the occurrence of sphagnum atolls in Central Minnesota," by Conway MacMillan, in which the structure and origin of these peculiar annular structures are discussed; "Some extensions of plant ranges," by E. P. Sheldon, in which a new Polygonum and a new Aster are described; "On the nomenclature of some N. Am. species of Astragalus," by E. P. Sheldon, in which the recent American rules of nomenclature are applied and two new species described; "List of fresh-water algæ collected in Minnesota during 1893," by Josephine E. Tilden, including eighty-nine numbers; "On the poisonous influence of Cypripedium spectabile and C. pubescens," by D. T. MacDougal, in which the poisonous effects of the former are reported to have been demonstrated, and inferred for the latter. A peculiar pointed hair and a glandular hair are looked to as possible causes of the irritation. Three plates illustrate the new Polygonum, the new Aster, and the hairs of Cypripedium.

IN THE *Kew Bulletin* for October and November (1893), some account is given of the botanical exploration of Sikkim-Tibet frontier (Bengal province of N. India). A long report is given by G. A. Gammie of a botanical tour in Sikkim in 1892, accompanied by a note from Sir Joseph Hooker, which comments in such an interesting way upon the general botanical features of the region that we quote as follows:

"Mr. Gammie's report strengthens in me the opinion which I have long entertained, but which I have never formulated, that Sikkim, for its area, presents one of the richest, if not the richest, botanical regions of the globe. And further, that though no more than about forty miles from east to west, and 100 from north to south, and situated beyond the northern tropic, I believe that, when all that is known of its vegetation shall have been brought together, it will prove to be a better microcosm of the flora of the globe than any other area of equal or even much larger dimensions.

Thus, in its alpine region, the floras of the European, Siberian, Chinese, and American mountains are all richly represented, and there also are found the principal types of the steppe and desert vegetations of Tibet and Central Asia. In its temperate region European genera abound in species in greater numbers than they do further west in the Himalaya, or probably than they do further east in the same range, where different climatic features prevail; and in the same region types of Chinese, Japanese, and North American (both eastern and western) genera appear in force, and which rapidly disappear in advancing toward the Western Himalaya. Lastly, in the tropical region, the Malayan flora disputes precedence with those of the plains and lower hills of the Indian continent, Burma and Ceylon, as represented by genera and species, many of which are also characteristic of tropical Africa. In short, with the exception of the prevalent types of the Australian, South African, and South American floras, there are few others that do not meet the eye of the wanderer in Sikkim."

Dr. D. H. Campbell is continuing his studies of the general relationships of the pteridophytes, and is each year furnishing more and more material upon which to base a natural classification. The latest subject of his investigation has been the development of *Azolla filculoides* Lam. It seems that it is this species rather than the eastern A. Caroliniana, that is found in California. With abundance of living material accessible, the author has made a complete study of the development of Azolla, concerning which litttle is known. The anatomy of the mature sporophyte had been thoroughly presented by Strasburger, but the account of the development of the prothallia and embryo was still incomplete.

After giving a brief account of the structure of the mature sporophyte, the author describes the development of the macrosporangia, the germination of the microspores, the germination of the macrospores, the development of the archegonia, of embryo, of the cotyledon, of the stem-quadrant, of the root, and of the foot. In every case resemblance to no other form is indicated by the development of Azolla, and the genus seems an isolated one, with Salvinia as its nearest living ally.

The general conclusions as to relationships are summed up as follows:

"That the two families of the Hydropterideæ represent the ends of two different lines of development. Of these the Salviniaceæ have been derived from the lower members of the leptosporangiate series, possibly from near the Hymenophyllaceæ, and that the Marsiliaceæ have arisen from forms more like the Polypodiaceæ. Of the two families, the Salviniaceæ have departed less from the parent stock in re-

gard to the reduction of the sexual generation, but the sporophyte is much less like that of the ordinary homosporous forms than that of the Marsiliaceæ.

The two genera of Salviniaceæ differ much more from each other than do those of the Marsiliaceæ, and it is not at all likely that one form has been derived from the other but that the two genera diverge at an early stage in the development of the line."

RECENT EXPERIMENT STATION bulletins include excellent data on methods and profit of spraying orchards, and on some new fungicides, by E. G. Lodeman (Cornell, N. Y., no. 60); on effect of fungicides upon germination of corn, with bibliography, by A. S. Hitchcock and M. A. Carleton (Kans., no. 41); on club root of cabbage and its allies, by B. D. Halsted (N. J., no. 98); on the tomato and some of its diseases, by P. H. Rolfs (Fla., no. 21); on common fungous diseases and methods of prevention, also on dodder, by C. V. Piper (Wash., no. 8); on the Russian thistle in Nebraska, by C. E. Bessey (Neb., no. 31); on the Russian thistle in Wisconsin, by E. S. Goff (Wisconsin, no. 27); and on winter-killing of trees and shrubs, by Aven Nelson (Wyoming, no. 15). The last is directed toward the causes of desiccation in winter and at high altitudes. Experiment showed that lowering the atmospheric pressure produced increased loss of moisture from an Ilex plant. Nevada weeds is a subject that is treated by F. H. Hillman (Nev., no. 21) in a manner that is almost model. A novel feature is introduced by attaching a fragment of the plant with a few seeds to the page to accompany the description. Eight of the most common weeds are described. half being illustrated with admirable half-tone cuts in addition to the dried specimens. A bulletin on fruit blight in general, by J. M. Stedman (Ala., no. 50), is a good example of pseudo-science, not half of the statements being true, and the experimental part being entirely unreliable. Electro-culture is again taken up by C. D. Warner (Hatch, Mass., no. 23), and although the experiments are apparently elaborate, they are almost wholly empirical, and grossly lacking in scientific detail. No attempt seems to have been made to determine the amount of current passing through the soil, but as near as one can judge from the data given, it was not half the total efficiency. Of course the amount of current passing exclusively through the wire is immaterial, unless magnetic effects are to be assumed, which is highly improbable. The author does not tell us whether a stimulation of the physiological action of the plant or electrolysis of the constituents of the soil is to be expected. The former is scarcely probable and the latter is out of the question with an alternating current. More profound experiments are needed to secure data of much value.